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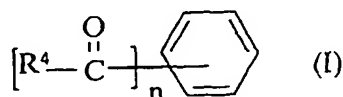
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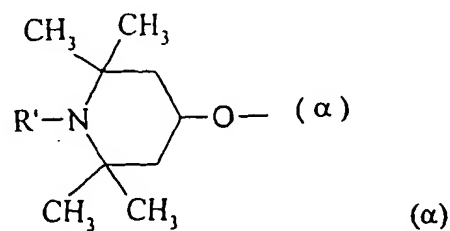
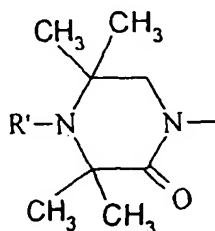
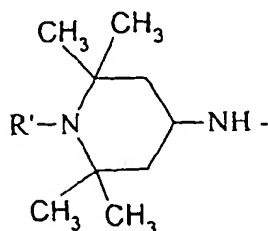
(54) Improved polyester polymers

(57) The disclosure pertains to an intimate molecular mixture of polyester with an effective amount of compound (I)



where n=2, 3 or 4 and at least one R⁴ group represents a sterically hindered amine group adjacent to the carbonyl, and preferably each R⁴ group is a hindered amino group.

Exemplary R⁴ groups are according to formulae (α):



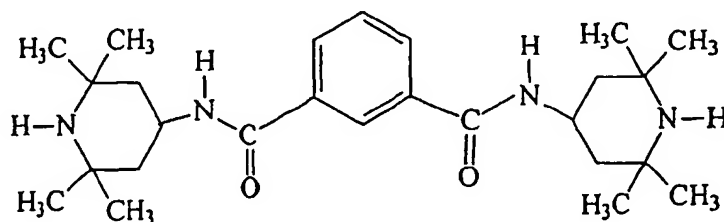
EP 1 000 967 A1

Description

[0001] This invention relates to novel polyester articles, such as films, fibers and moldings, and to a process for improving the physical properties of polyester obtained after melt processing and aging. In the practice of the invention improvements in processing (heat) stability, light stability, chemical stability and dyeability of polyester is achieved. The long-term stability of colorants in dyed or pigmented polyesters is also improved.

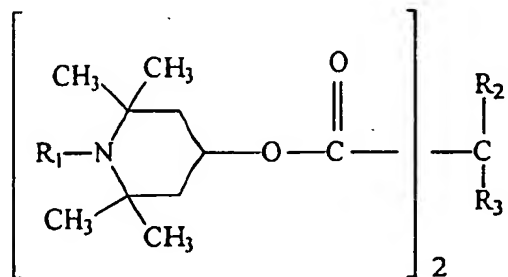
[0002] Polyesters are in general worked, in particular during spinning processes, at temperatures of the order of 270°C or above. At these temperatures degradation of the polymer is ongoing and results in loss of initial and long-term physical properties. Loss of physical properties is problematic particularly from the standpoint of spinning of synthetic polyester. The through-put of polyester spinning processes is disrupted with the result that the polymer is exposed to the high temperatures of the spinning apparatus for longer periods than would be expected under normal running of the apparatus. Polyester must be stabilized for light stability, in addition due to the susceptibility to oxidation, for thermal-aging and oxidative chemical stability.

[0003] WIPO publication WO 97/43335 discloses a stabilizer for polyamide having the structure (A):



[0004] Various stabilization means for polyester are known.

[0005] Japanese Patent Publication No. 75/91652 discloses the use of a number of hindered piperidine type photostabilizers in combination with phenolic antioxidants in copolyetheresters. However, it has been previously noted, according to U.S. Pat. No. 4,185,003, that when the teaching of this Japanese Publication is followed, photostabilization is improved, however heat-aging behavior is worsened (see, column 1, lines 30-45 of U.S. Pat. No. 4,185,003). The improvement taught in U.S. 4,185,003 is the combination of the copolyester with phenolic antioxidant and hindered amine having the structure:



(B)

where R_1 is hydrogen or an alkyl radical of 1-12, preferably 1-4 carbon atoms and R_2 and R_3 represent an alkyl radical.

[0006] It would be desirable to provide terephthalate-based polyester which exhibit improved initial and aged retention of physical properties, as these types of polyesters are more abundant and economical.

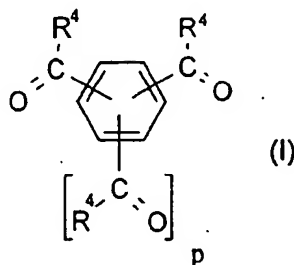
[0007] Two considerations are needed to understand sources of failure in phthalate-based polyesters which are exposed to heat and light. Firstly, the heat stabilizing ability during processing of the fiber and UV resistance under long term UV exposure, and secondly the resistance to heat setting treatments to provide bonding of multifilament yarns to structural warp and/or weft fibers. In aging studies retention of fiber strength and elongation properties is critical for heat-set elastomeric phthalate-based fibers. The redistribution and/or deactivation has significant effects on

long term retention of tensile strength and elongation after long-term exposures to UV irradiation. Specifically, conventional stabilized terephthalate-based polyester after heat setting can exhibit up to 50% loss in tensile strength and elongation properties after exposure simulating automotive fabrics, that is after 451 kilojoules per square meter of irradiation under standard test SAE J-1885.

[0008] It would be of commercial importance to obtain durable phthalate-based polyester, suitable for automotive fabrics, and carpet, which have improved aging retention of physical properties after heat setting, and improved long term retention of physical properties and color after exposure to UV irradiation.

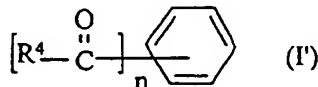
SUMMARY OF THE INVENTION

[0009] It is the object of the present invention to provide improvements for polyesters to overcome the above-mentioned short-comings. This object is achieved by the incorporation into polyester as an intimate mixture of a compound according to



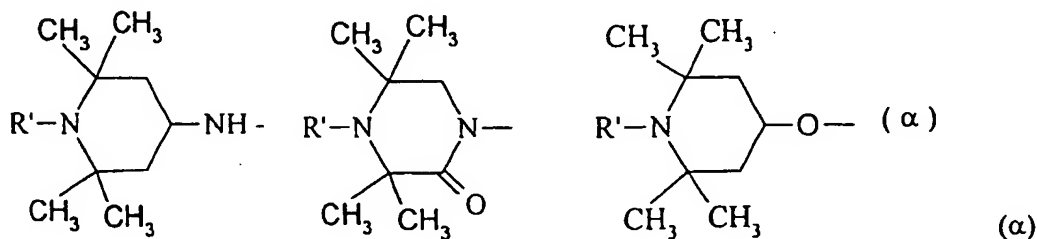
wherein R^4 is the rest of an organic amino or hydroxy compound and p is 0, 1 or 2.

Where $p=0$, the invention pertains to an intimate molecular mixture of polyester with an effective amount of compound (I')



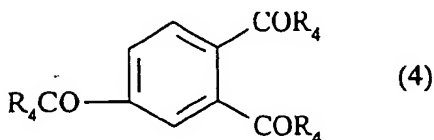
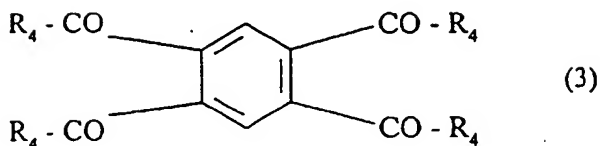
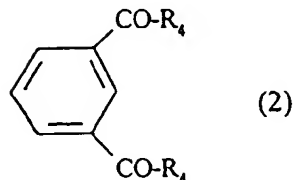
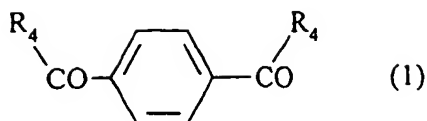
where $n=2$ and preferably, at least one R^4 group represents a sterically hindered amino group adjacent to the carbonyl, and more preferably each R^4 group is a hindered amino group.

[0010] Exemplary, and preferred R^4 groups are selected from the group consisting of formulae (α)



wherein for either α structure, R' is hydrogen, C_{1-6} alkyl, C_{1-4} alkoxy or ---CO---C_{1-4} alkyl.

[0011] Exemplary members of the class of compounds according to formula (I) include compounds of the formulae (1), (2), (3) and (4)



in which R_4 represents one of the formulae (α)

[0012] The invention provides in another one of its aspects a process to modify polyester comprising incorporating therein prior to, during or after polycondensation of the polyester an effective amount of a compound according to formula (I). Alternatively, the process comprises incorporating therein a masterbatch composition comprising generally 10 to 80% by weight, preferably 5 to 50% by weight, more preferably 15 to 40% by weight of the compound of formula (I) and 90 to 20% by weight, preferably 95 to 50% by weight, more preferably 85 to 60% by weight of a thermoplastic polyester carrier polymer or a carrier polymer which is miscible, or compatible with the polyester.

[0013] The modified polyester according to the invention exhibited unexpected improved physical properties and enhanced dye affinity as evidenced by stronger dye retention if the intimate mixture of an effective amount of (I) is made prior to dyeing.

[0014] The invention provides in another one of its aspects a method of improving the coloring of synthetic polyesters in the mass by mixing together a synthetic polyester, a suitable dyestuff, such as disperse, cationic and acid dyes, or known pigments along with the compound according to formula (I) as defined above.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] The synthetic polyester polymers are well known in the art and commercially available worldwide. The polyester can be a homopolyester, a copolyester, a mixture or blend of polyesters or of a polyester blend with another polymer other than polyester. Typical manufacturing is via direct esterification of a dicarboxylic acid such as terephthalic acid (TA) with a glycol such as ethylene glycol (EG) (primary esterification to an average degree of polymerization (DP) of 2 to 3) followed by a melt or solid stage polymerization to a DP which is commercially usable (70 DP and higher). The phthalate-based polyesters are linear and cyclic polyalkylene terephthalates, particularly polyethylene terephthalate (PET), polypropylene terephthalate (PPT), polybutylene terephthalate (PBT), polyethylene-1,4-cyclohexylenedimethylene terephthalate (PETG), polytrimethylene terephthalate (PTT), polyamide-block-PET, and other versions.

e.g., random or block copolymers thereof containing one or more of the above components. Copolyesters are generally copolymers containing soft segments, e.g., polybutylene terephthalate (PBT) and hard segments, e.g., polytetramethylene ether glycol terephthalate. Phthalate-based polyester and copolyesters are commercially available from duPont De Nemours, Inc. and Trevira® in the U.S. under the Hytrel® and Riteflex® trademarks. Copolyesters can be prepared by polymerizing (a) one or more aromatic dicarboxylic acids or their equivalents (and esters or ester-forming derivatives such as acid chlorides, anhydrides, etc.), (b) one or more linear long chain glycols, and (c) one or more low molecular weight diols. Examples of suitable dicarboxylic acids include but are not limited to isophthalic acid, naphthalene dicarboxylic acid, 4,4'-biphenyldicarboxylic acid, adipic acid. "Diol" as used herein refers to monomers having at least two hydroxy groups. Examples of suitable diols include but are not limited to ethylene glycol, bisphenol A, butanediol, propanediol, neopentyl glycol, cyclohexyldimethanol, hydroquinone, and biphenol. Preferably terephthalic acid-based polyester (referred to as PET) is used in the present invention. Exemplary copolyesters are copolymers of polybutylene terephthalate and polytetramethylene glycol; block copolymer of polybutylene terephthalate/polybutylene isophthalate and polyethylene glycol/polypropylene glycol, a block copolymer of polybutylene terephthalate/polyhexene terephthalate and polytetramethylene glycol, and a block copolymer of polyurethane and polytetramethylene glycol.

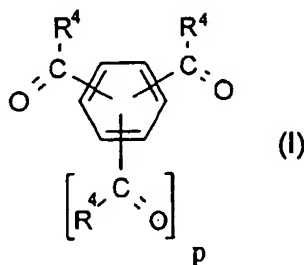
[0016] Articles of manufacture of commercial importance in the practice of the invention are the polyester fibers. Included are the conjugate fibers referred to as core-sheath fibers, such as polyolefin-polyester conjugate fibers.

[0017] Synthetic polyesters modified according to the invention are preferably dyed or pigmented, for example by topical application as in a dye bath or by incorporation of dye in the melt in accordance with conventional methodology. Any type of dyestuff or pigment is suitable for incorporation in the melt, provided that it is stable at the high temperatures encountered in the melt. Preferred dyestuffs are monoazo complexes, in particular, the chromium complexes that are sufficiently stable at the high working temperatures encountered in, e.g. a spinning process. Preferred reactive dyestuffs are those halogen-containing triazinyl or vinyl group-containing metallized azo dyestuffs, in particular, those metallized with chromium, nickel or copper. Preferred pigments to name a few are, for example Pigment Yellow 192, Pigment Orange 68 and Pigment Red 149. Preferred polymer soluble dyes are for example Solvent Red 179.

[0018] The preparation of modified synthetic polyesters according to the invention can be performed in mass by mixing an effective amount of compound (I) with molten polyester, e.g. in an extruder prior to spinning, or before or during the polycondensation process of the synthetic polyester itself.

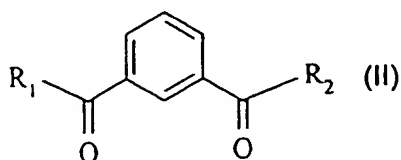
COMPOUND (I)

[0019] The aromatic -carbonyl compound intimately mixed with polyester, or with precursor monomers or oligomers of polyester is a monomeric, nonpolymerized, aromatic amide or aromatic ester-amide (aromatic (ester)amide) containing at least one hindered amine group adjacent to carbonyl carbons. The structure is most generally given by:

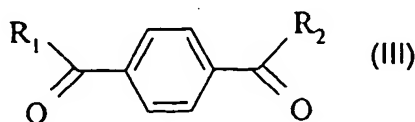


where p is 0, 1 or 2 and R_4 represents the rest of an organic amino or hydroxy compound, preferably at least one being a sterically hindered amine group adjacent to the carbonyl and any other R_4 represents the rest of an ester or amide group.

[0020] When p is 0, the aromatic di-carbonyl (ester)amide preferably is (II) or (III),

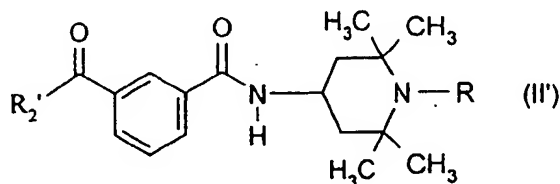


or



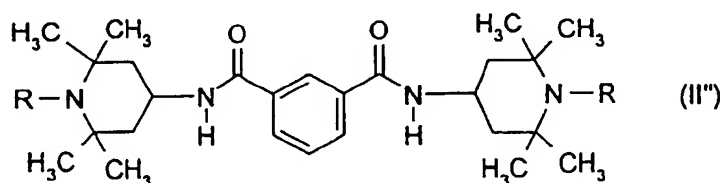
wherein at least one of R_1 and R_2 is, independently, an identical or different sterically hindered amino groups adjacent to the carbonyl group and any other group R_1 or R_2 represents the rest of an organic amino or hydroxy compound. Preferably both R_1 and R_2 are hindered amino groups (a). Where one of R_1 and R_2 are not hindered amino groups such group can be alkylamino which may optionally be substituted by halogen, hydroxy, carboxyl groups, carbamyl groups or C_{1-12} alkoxy carbonyl groups, or a C_{3-5} alkenyloxy, unsubstituted benzyloxy or benzyloxy which is substituted by halogen or C_{1-5} alkyl, aliphatic acyloxy containing up to 18 carbon atoms, unsubstituted benzoyloxy or benzoyloxy which is substituted by halogen or C_{1-4} alkyl.

[0021] A preferred aromatic dicarbonyl compound is (II'):



wherein R_2' is either optionally further substituted C_{1-20} alkylamino or optionally further substituted C_{1-20} alkoxy.

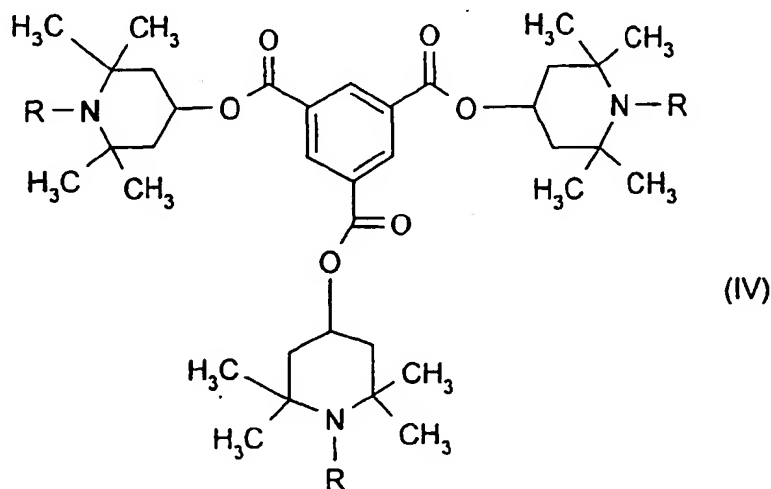
[0022] More preferred is the aromatic dicarbonyl compound (II''):

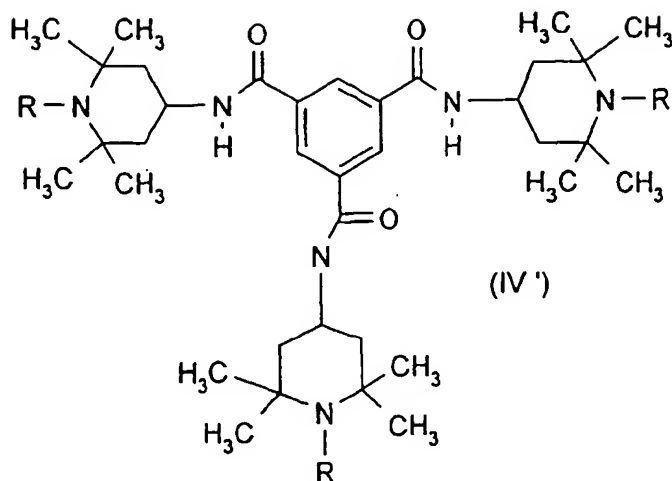


whereby each R in II' and II'' is, independently, either hydrogen, C_{1-18} alkyl, O, OH, CH_2CN , C_{1-18} alkoxy, alkoxy-alkylenoxyalkyl, C_{5-12} cycloalkoxy, C_{3-6} alkenyl, C_{7-9} phenylalkyl which is unsubstituted or mono-, di- or tri-substituted on the phenyl by C_{1-4} alkyl; or $-COR_5$, where R_5 is hydrogen, C_{1-6} alkyl, phenyl or $-C_{1-20}$ alkyl-COO(H or C_{1-4} alkyl).

[0023] When more than one hindered amine group is present they can be identical or different, and preferably are identical hindered amine groups.

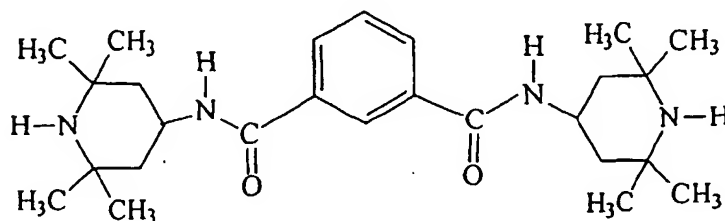
[0024] Exemplary aromatic tri-carbonyl compounds are the following IV and IV',





wherein R is defined as in II' or II''

[0025] The most preferred aromatic (ester) amide is an aromatic di-amide having the following structure (A):



and is commercially available as NYLOSTAB® S-EED™ from Clariant.

[0026] The aromatic di- or tri-carbonyl (ester) amide compounds can be prepared by known means, for example, by the reaction of an aromatic di- or tri-carboxylic acid di- or tri-chloride with 2,2,6,6-tetramethyl-4-amino-piperidine. As one example 1,3,5-tri-(2',2',6',6'-tetramethylpiperidyl-4')-trimesic acid amide is prepared by reaction as follows:

42 grams of trimesic acid are heated for 5 hours at 80°C with 144.0 ml of thionyl chloride in the presence of catalytic quantities (3 ml) of dimethylformamide and then the excess thionyl chloride is distilled off. The trimesic acid trichloride thus formed is dissolved in 500 ml of dioxane, then a total of 187.2 g of 2,2,6,6-tetramethyl-4-aminopiperidine is added dropwise while stirring, whereby dioxane (2000 ml in all) is constantly added to allow the reaction mixture to remain stirrable. The temperature of the reaction mixture is not allowed to exceed 30°C. The reaction mixture is subsequently boiled for 48 hours with reflux cooling, the residue is filtered, washed with acetone, dissolved in approx. 1000 ml of water, precipitated again with soda solution (pH 10 - 11), filtered, and the residue washed with water and vacuum-dried, yielding 89.2 g (72%) of a white powder having a melting point of >320°C. Isophthalic acid, or terephthalic acid likewise can be substituted in the above, and under suitable conditions the corresponding acid amides can be made, e.g. 1,3- or 1,4-di-(2',2',6',6'-tetramethylpiperidyl-4')-phthalic acid amide having a melting point of.

[0027] In like manner the reaction above can be made substituting 2,2,6,6-tetramethyl-4-aminopiperidine with 2,2,6,6-tetramethyl piperazine, and likewise the N-substituted hindered amines, which are substituted with following N-substituents may be used: C₁₋₁₈ alkyl, O, OH, CH₂CN, C₁₋₁₈alkoxy, alkoxyalkylenoxyalkyl, C₅₋₁₂cycloalkoxy, C₃₋₆alkenyl, C₇₋₉ phenylalkyl unsubstituted or mono-, di- or tri-substituted on the phenyl by C₁₋₄alkyl; or aliphatic or aromatic C₁₋₁₀ acyl groups.

[0028] The synthetic polyesters stabilized according to the invention can be prepared by conventional means, where a compound according to formula (I) is incorporated prior to, during, or after esterification or polycondensation polym-

erization of the resin. The preferred method of incorporating (I) is by mixing with commercially available polyester in the molten state. While the molten synthetic polyester is in a suitable receptacle, for example in an extruder, (I) is introduced into the receptacle and is worked into the resin to give a uniform dispersion prior to molding, extruding or spinning.

5 [0029] An effective amount of (I) ranges from 0.2 to 2.0 % by weight of (I) based on the weight of synthetic polyesters to which (I) is added. Surprising effects are seen at a level of 0.3% to 1.0% by weight of the most preferred compound (A) especially.

[0030] Synthetic polyester having incorporated the above mentioned effective amount of (A) resulted in surprising improvement in heat-stability, light stability, chemical stability and dye affinity of the polyester polymer as well as the stability and the light resistance of the coloring agent in the dyed or pigmented polyester as compared to the state of the art, without affecting certain desirable physical characteristics of the polymer, for example the relative viscosity and the degree of polymerization. Furthermore, the synthetic polyester exhibits a decreased tendency to yellow and exhibited unexpected improved unaged and aged stretchability and tensile strength.

[0031] If dyestuffs or pigments are employed in the synthetic polyesters they are preferably employed in amounts generally ranging from 0.1 to 10 wt. parts, more preferably 0.1 to 4 wt. parts per 100 wt. parts of the synthetic polyester. If reactive dyes are used to dye modified synthetic polyesters according to the invention, in general between 0.05 and 5% by weight of the reactive dyes are used based on the weight of polyester. More preferably the amount of reactive dye used is from 0.1 to 3% by weight. The dyeings so obtained are also deeper than exhaust dyeings made with the same amount of dye on polyester of the state of the art.

20 [0032] Synthetic polyester according to the invention can additionally comprise fillers or fibers, for example glass spheres or glass fibers, and/or delusterants, for example titanium dioxide contained at about 0.1 to 5.0 parts, more typically 0.2 to 2.0 parts per 100 parts of polyester.

[0033] UV absorbing stabilizers can be included. UV absorbers include, for example, the class of benzotriazoles, oxanilides, hydroxy substituted benzophenones, triazines, p-methoxy benzylidene malonate esters, including reaction products of p-methoxy benzylidene malonate with hindered amino groups such as Sanduvor®PR-31 from Clariant.

25 [0034] A masterbatch composition may comprise in addition to the additive according to the invention a coloring agent. In this case such compositions comprise 2.5 to 40% by weight, preferably 5 to 25% by weight of the compound of formula (I), 5 to 40% by weight, preferably 7.5 to 20% by weight of a suitable dye or pigment and 95 to 50% by weight, preferably 85 to 60% by weight of polyester carrier polymer or a polymer dispersible in polyester, as conventionally employed in the art.

30 [0035] In the following examples which are illustrative of the invention all parts and percentages are by weight and all temperatures are given in degrees Celsius.

EXAMPLES

35

I. Production of polyester yarn

[0036] Polyester chips are dried in a vacuum tumble drier for 8 hours at a temperature of 110° or 125°. 2 kg batches of the dried polymer are combined and blended with an appropriate amount of a pre-dried compound according to formula (A) to form 0.1% to 1.0% mixtures in polyester. Filament yarns are melt-spun from the mixtures under typical processing temperatures of above 260°, preferably 290°C using the following equipment: An extruder fitted with one dynamic mixer at the top of the 30mm-screw and two static mixers before the spinning head. For winding of the filament yarns consisting of 120 filaments, a BARMAG SW46 winder is used together with two godets. The as-spun yarns are optionally drawn subsequently using, for example a DIENES® draw-twisting machine.

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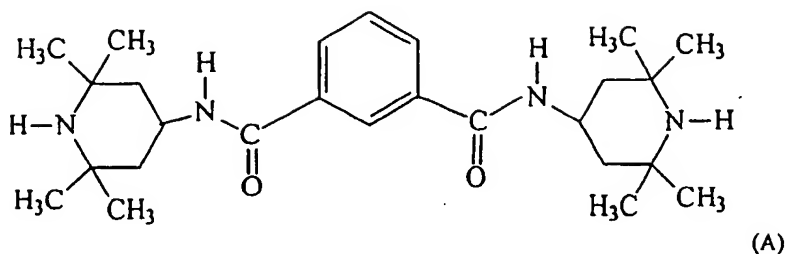
II. Comparative data

[0037] The following additive compounds were employed for comparisons in spun PET fibers dyed with C.I. PIGMENT YELLOW 147 (PY-147, Table 1) and C.I. PIGMENT RED 144 (Table 2):

50 **PS-1** a sterically hindered phosphonite processing stabilizer commercially available as Sandostab® P-EPC® from Clariant.

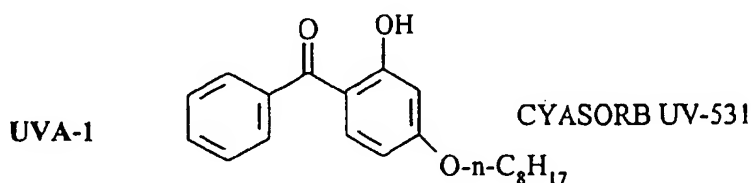
[0038] Compound (A) commercially available as NYLOSTAB®S-EED™ from Clariant:

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HALS-1 high MW tertiary hindered amine used for PET - Chimmasorb® 119

HALS-2 hindered amine - Chimmasorb 944, HALS-3 hindered amine - Cyasorb 3346



25 [0039] The following physical testing methods were applied to polyester fibers, which were spun in a commercial scale production facility. The yarns contained dyes, which are known to adversely affect the physical properties of the fiber after exposure to UV irradiation.

- 30
- TENSILE STRENGTH - ASTM D2256 Standard Test method for Tensile Properties of Yarns by the single-strand Method (option 1, conditioned specimen, using Instron® CRE tester and 20 pound load cell, at an extension rate of 12 inches per minute, and a 10-inch gauge length, and the yarn contained 120 filaments per bundle
 - UV EXPOSURE - in accordance with AATCC Test Method 16, option E, water-colored Xenon-Arc Lamp, Continuous Light, irradiance level of 1.10W/m² using 420 nm filters, 63° black body temperature, and 30% relative humidity.
 - 35 - GRAY SCALE - The AATCC Evaluation Procedure 1, for Gray Scale for Color Changes was utilized to detect shade differences in the polyester yarns. See Revisions May, 1, 1982 in the AATCC Technical Manual. The degree of alteration in Lightness, Hue and chroma of color in grades 1-5 are: Grade 5- negligible or no change; 4 = slightly changed; 3 = noticeably changed; 2 = considerably changed; and 1 - much changed.

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Yarn contents	Initial		200 ATCC Fading Units Exposure	
	Tensile	% Elongation	Tensile	% Elongation
0.1%PY 147	16.6	78.8	10.7	52.0
45 0.5%PY 147	16.9	80.9	8.4	34.7
0.1%PY 147 +0.1% SEED	14.3	73.0	11.5	58.0
0.5% PY147+0.5% SEED	16.2	77.0	15.2	70.6

50 [0040] Additional spun PET yarns were prepared and exposed according to AATCC Test method 16 with the following physical properties obtained:

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Table 1

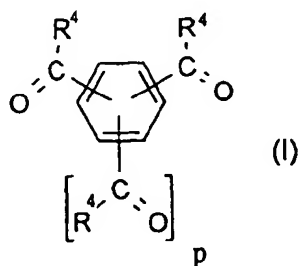
Test	Colorant (%)	Additive %	GRAY (200 hr)	GRAY (300 hr)
1y	0.1 % Yellow 147	None-control	3-4	3
2y	0.5% yellow 147	None-control	3-4	3
3y	0.1% Yellow 147	0.1% UVA-1	3-4	3
4y	0.5% yellow 147	0.5% UVA-1	4	3-4
5y	0.1 % Yellow 147	0.1% HALS-1	4	3-4
6y	0.5% yellow 147	0.5% HALS-1	3-4	3-4
7y	0.1% Yellow 147	0.1% (II)	4	4
8y	0.5% yellow 147	0.5% (II),	4	4
9y	0.1 % Yellow 147	0.1% PS-1	3	2-3
10y	0.5% yellow 147	0.5% PS-1	3	2-3
11y	0.1% Yellow 147	0.1% PSI + 0.1% (II)	3-4	3
12y	0.5% yellow 147	0.5% PSI + 0.5% (II)	3-4	3-4

Table 2

Test	Colorant (%)	Additive %	GRAY (200 hr)	GRAY (300 hr)
1r	0.1 % Red 144	None-control	4	3-4
2r	0.5% Red 144	None-control	4	4
3r	0.1% Red 144	0.1% UVA-1	4-5	4
4r	0.5% Red 144	0.5% UVA-1	4	4
5r	0.1 % Red144	0.1% HALS-1	4-5	4
6r	0.5% Red 144	0.5% HALS-1	4-5	4
7r	0.1% Red 144	0.1% (II)	4	3-4
8r	0.5% Red 144	0.5% (II)	4-5	4
9r	0.1 % Red 144	0.1% PS-1	4	3-4
10r	0.5% Red 144	0.5% PS-1	4-5	4
11r	0.1% Red 144	0.1% PS-1 + 0.1% (II)	4	3-4
12r	0.5% Red 144	0.5% PS-1 + 0.5% (II)	4	4

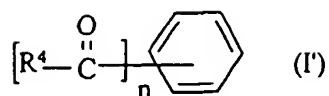
Claims

1. A polyester polymer in intimate mixture with an effective amount of compound (I)



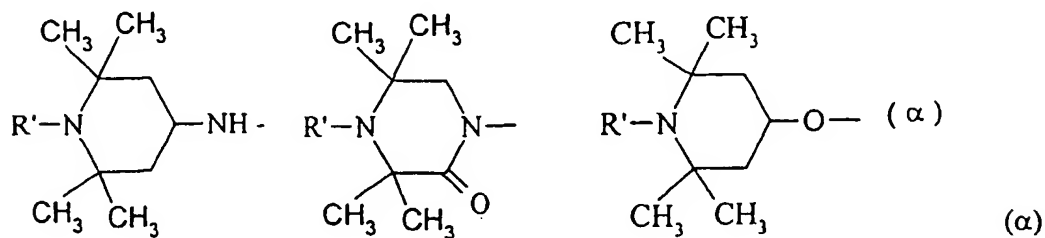
wherein $n=2, 3$ or 4 and at least one R^4 group represents a sterically hindered amine group adjacent to the carbonyl, and any other R^4 represents the rest of an organic amino or hydroxy compound.

2. The polyester of claim 1 wherein compound (I) corresponds to formula (I')



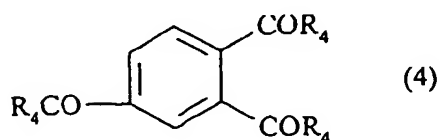
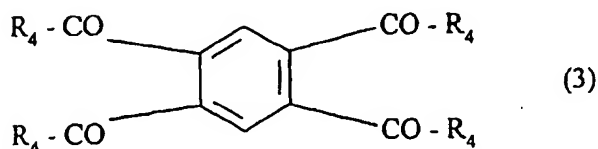
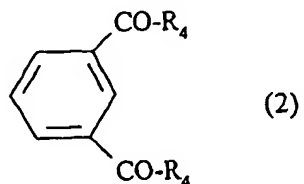
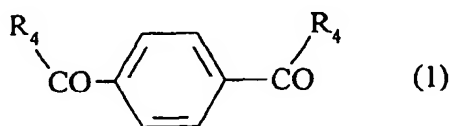
where $n=2$ and at least one R^4 group represents a sterically hindered amino group adjacent to the carbonyl.

3. The polyester of claim 2 wherein R^4 is selected from the group consisting of formulae (a)



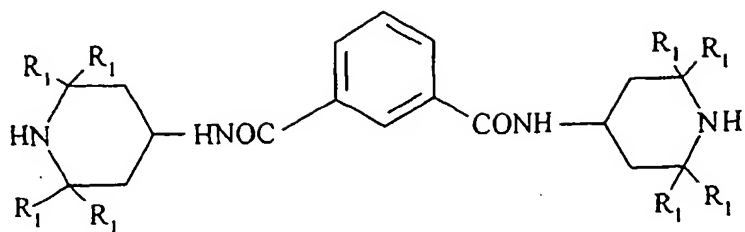
wherein for either α structure R' is hydrogen, C_{1-6} alkyl, C_{1-4} alkoxy or $-\text{CO}-C_{1-4}$ alkyl.

4. The polyester of claim 2 wherein (I) is selected from the group consisting of



wherein R_4 is defined above as in claim 2.

5. The polyester of claim 3 wherein (I) is



wherein R_1 represents a methyl group.

6. The polyester of claim 1 wherein (I) is present in an amount of from 0.1 to 5.0 parts by weight per 100 parts by weight of the said polyester.
7. A process to modify polyester comprising incorporating therein prior to, during or after polycondensation of the polyester an effective amount of a compound according to formula (I) as defined in claim 1.
8. A process of improving the coloring of synthetic polyesters in the mass by mixing together the polyester of claim 1, with a dyestuff or pigment.
9. A masterbatch composition comprising polyester, or a polymer carrier at least miscible with polyester and a compound of formula (I) as defined in claim 1.
10. The polyester of claim 1 in the form of a fiber.



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 81 1042

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. CL.7)
X, D	WO 97 43335 A (CLARIANT FINANCE LTD) 20 November 1997 (1997-11-20) * the whole document *	1-10	C08K5/3435
A	US 4 525 504 A (EASTMAN KODAK) 25 June 1985 (1985-06-25) * claims; examples *	1-7	
			TECHNICAL FIELDS SEARCHED (Int. CL.7)
			C08K
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 17 February 2000	Examiner Friederich, P
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

EPO FORM 1503 03/82 (P04011)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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17-02-2000

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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82